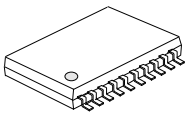
8-BIT BIDIRECTIONAL, LEVEL-SHIFTING, VOLTAGE TRANSLATOR FOR OPEN-DRAIN AND PUSH-PULL APPLICATION



TSSOP-20

■ DESCRIPTION

This 8-bit non-inverting translator is a bidirectional voltage-level translator and can be used to establish digital switching compatibility between mixed-voltage systems. It uses two separate configurable power-supply rails. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 1.4V to 3.6V.The B port is designed to track V_{CCB}. V_{CCA} must be less than or equal to V_{CCB}. V_{CCB} accepts any supply voltage from 1.65V to 5.5V. This allows for low voltage bidirectional translation between any of the 1.5V, 1.8V, 2.5V, 3.3V, and 5V voltage nodes.

When the output-enable(OE) input is low, all outputs are placed in the high-impedance state.

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pull-down resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

■ FEATURES

* 1.4V to 3.6V on A port and 1.65V to 5.5V on B Port ($V_{CCA} \leq V_{CCB}$)
* No power-supply sequencing required – either V_{CCA} or V_{CCB} can be ramped first
* No direction-control signal needed

■ APPLICATION

* Handset
* Smartphone
* Tablet
* Desktop PC

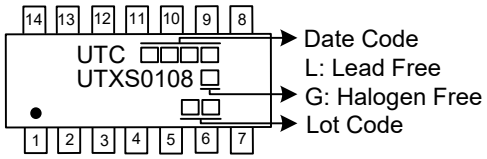
■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UTXS0108L-P20-R	UTXS0108G-P20-R	TSSOP-20	Tape Reel

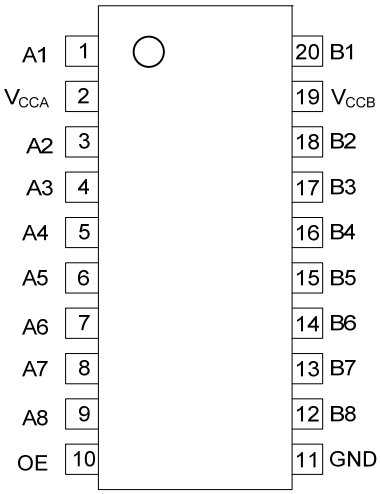
UTXS0108G-P20-R
- (1)Packing Type
- (2) Package Type
- (3) Green Package

(1) R: Tape Reel
(2) P20: TSSOP-20
(3) G: Halogen Free and Lead Free, L: Lead Free

■ MARKING



■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	I/O	DESCRIPTION
1	A1	I/O	Input/output A1. Referenced to V_{CCA}
2	V_{CCA}	P	A-Port supply voltage.1.4V ≤ V_{CCA} ≤ 3.6V and V_{CCA} ≤ V_{CCB}
3	A2	I/O	Input/output A2. Referenced to V_{CCA}
4	A3	I/O	Input/output A3. Referenced to V_{CCA}
5	A4	I/O	Input/output A4. Referenced to V_{CCA}
6	A5	I/O	Input/output A5. Referenced to V_{CCA}
7	A6	I/O	Input/output A6. Referenced to V_{CCA}
8	A7	I/O	Input/output A7. Referenced to V_{CCA}
9	A8	I/O	Input/output A8. Referenced to V_{CCA}
10	OE	I	Output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V_{CCA}.
11	GND		Ground
12	B8	I/O	Input/output B8. Referenced to V_{CCB}
13	B7	I/O	Input/output B7. Referenced to V_{CCB}
14	B6	I/O	Input/output B6. Referenced to V_{CCB}
15	B5	I/O	Input/output B5. Referenced to V_{CCB}
16	B4	I/O	Input/output B4. Referenced to V_{CCB}
17	B3	I/O	Input/output B3. Referenced to V_{CCB}
18	B2	I/O	Input/output B2. Referenced to V_{CCB}
19	V_{CCB}	P	B-Port supply voltage.1.65V ≤ V_{CCB} ≤ 5.5V
20	B1	I/O	Input/output B1. Referenced to V_{CCB}

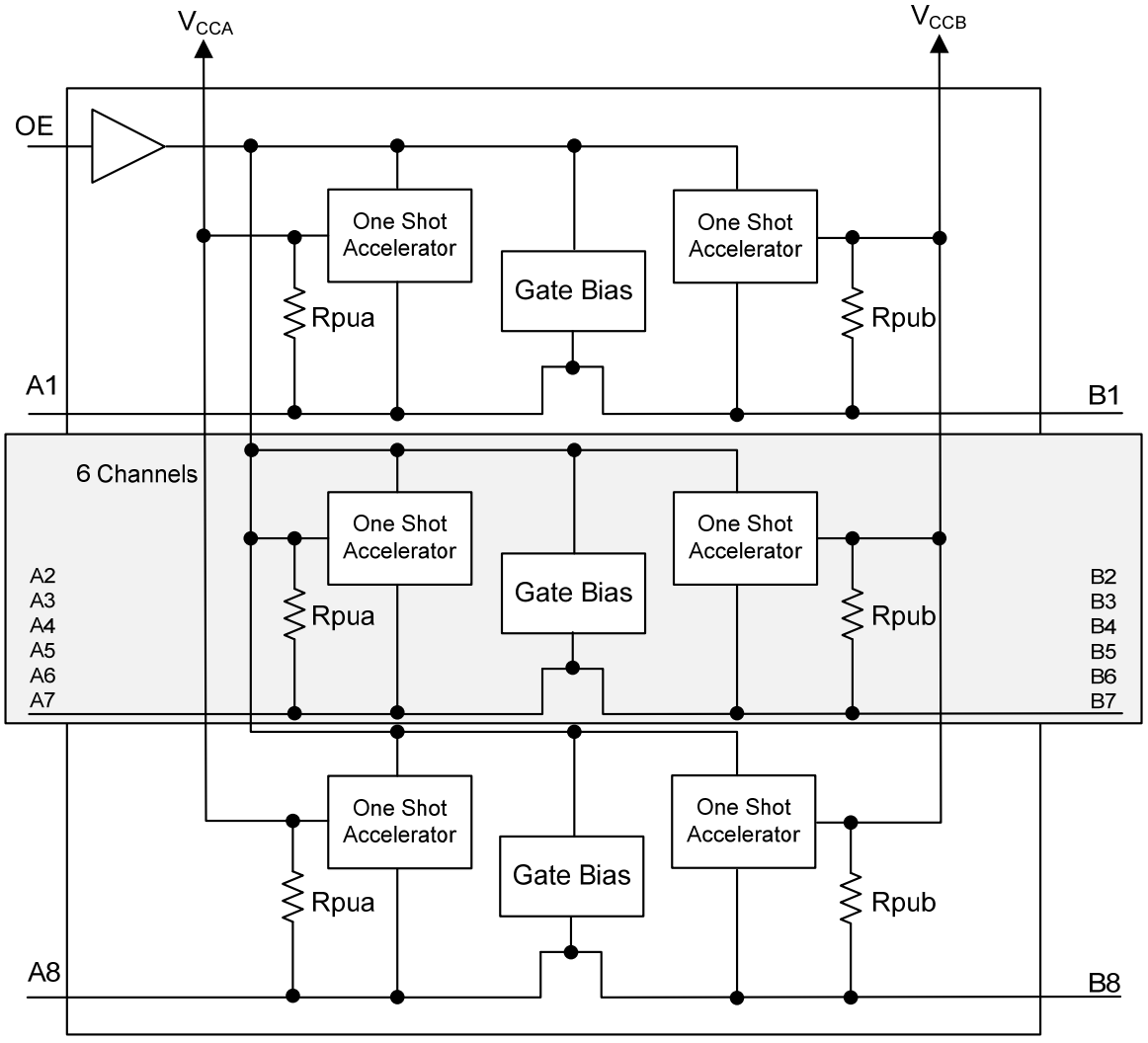
Note: I=Input, I/O=Input and Output, P=Power

■ FUNCTION TABLE

SUPPLY VOLTAGE		INPUTS	INPUTS/OUTPUT	
V_{CCA}	V_{CCB}	OE	An	Bn
1.4V ~ V_{CCB}	1.65V ~ 5.5V	L	Z	Z
1.4V ~ V_{CCB}	1.65V ~ 5.5V	H	Input or Output	Output or Input
GND (Note 2)	GND (Note 2)	X	Z	Z

Notes: 1. H = High voltage level；L = Low voltage level；Z : High impedance OFF-state；X = Don't care.
2. When either V_{CCA} or V_{CCB} is at GND level, the device goes into Power-down mode.

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING (Unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Supply voltage		V_{CCA}	-0.5 ~ 4.6	V
Supply voltage		V_{CCB}	-0.5 ~ 6.5	V
Input voltage	A Port	V_{IN}	-0.5 ~ 4.6	V
	B Port		-0.5 ~ 6.5	V
Voltage range applied to any output in the high-impedance or power-off state	A Port	V_{OUT}	-0.5 ~ 4.6	V
	B Port		-0.5 ~ 6.5	V
Voltage range applied to any output in the high or low state	A Port	V_{OUT}	-0.5 ~ V_{CCA}+0.5	V
	B Port		-0.5 ~ V_{CCB}+0.5	V
Input clamp current	V_I<0	I_{IK}	-50	mA
Output clamp current	V_O<0	I_{OK}	-50	mA
Continuous output current		I_O	±50	mA
Continuous current through V_{CCA}, V_{CCB}, or GND		I_{CC} / I_{GND}	±100	mA
Storage Temperature		T_{STG}	-65 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ RECOMMENDED OPERATING CONDITIONS (Unless otherwise specified)

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage (Note 3)		V_{CCA}		1.4		3.6	V
Supply Voltage (Note 3)		V_{CCB}		1.65		5.5	V
Input Voltage		V_{IN}		0		V_{CCI}	V
Output Voltage	A Port I/Os	V_{OUT}	V_{CCA}=1.4V~3.6V, V_{CCB}=1.65V~5.5V	0		3.6	V
	B Port I/Os			0		5.5	V
High-Level Input Voltage	A Port I/Os	V_{IH}	V_{CCA}=1.4V~1.95V, V_{CCB}=1.65V~5.5V	V_{CCI}-0.2		V_{CCI}	V
			V_{CCA}=1.95V~3.6V, V_{CCB}=1.65V~5.5V	V_{CCI}-0.4		V_{CCI}	V
	B Port I/Os		V_{CCA}=1.4V~3.6V, V_{CCB}=1.65V~5.5V	V_{CCI}-0.4		V_{CCI}	V
	OE			V_{CCA} ×0.65		5.5	V
Low-Level Input Voltage	A Port I/Os	V_{IL}	V_{CCA}=1.4V~1.95V, V_{CCB}=1.65V~5.5V	0		0.15	V
			V_{CCA}=1.95V~3.6V, V_{CCB}=1.65V~5.5V	0		0.15	V
	B Port I/Os		V_{CCA}=1.4V~3.6V, V_{CCB}=1.65V~5.5V	0		0.15	V
	OE			0		V_{CCA} ×0.35	V
Input Transition Rise or Fall Rate	A Port I/Os	Δt/Δv	V_{CCA}=1.4V~3.6V, V_{CCB}=1.65V~5.5V			10	ns/V
	B Port I/Os					10	ns/V
	OE					10	ns/V
Operating Temperature		T_A		-40		+125	°C

Notes: 1. V_{CCI} is the supply voltage associated with the input port.
2. V_{CCO} is the supply voltage associated with the output port.
3. V_{CCA} must be less than or equal to V_{CCB}, and V_{CCA} must not exceed 3.6V.

■ ELECTRICAL CHARACTERISTICS (Unless otherwise specified)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Port A Output High Voltage		V_{OHA}	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V I_{OH}=-20μA, V_{IB}≥V_{CCB}-0.4V			V_{CCA} ×0.67		V
Port A Output Low Voltage		V_{OLA}	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V, I_{OL}=180μA, V_{IB}≤0.15V				0.4	V
			V_{CCA}=1.65V, V_{CCB}=1.65V~5.5V, I_{OL}=220μA, V_{IB}≤0.15V				0.4	V
			V_{CCA}=2.3V, V_{CCB}=1.65V~5.5V, I_{OL}=300μA, V_{IB}≤0.15V				0.4	V
			V_{CCA}=3.0V, V_{CCB}=1.65V~5.5V, I_{OL}=400μA, V_{IB}≤0.15V				0.55	V
Port B Output High Voltage		V_{OHB}	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V I_{OH}=-20μA, V_{IA}≥V_{CCA}-0.2V			V_{CCA} ×0.67		V
Port B Output Low Voltage		V_{OLB}	V_{CCA}=1.4V~3.6V, V_{CCB}=1.65V, I_{OL}=220μA, V_{IA}≤0.15V				0.4	V
			V_{CCA}=1.4V~3.6V, V_{CCB}=2.3V, I_{OL}=300μA, V_{IA}≤0.15V				0.4	V
			V_{CCA}=1.4V~3.6V, V_{CCB}=3.0V, I_{OL}=400μA, V_{IA}≤0.15V				0.4	V
			V_{CCA}=1.4V~3.6V, V_{CCB}=4.5V, I_{OL}=620μA, V_{IA}≤0.15V				0.55	V
Input Leakage Current	OE	$I_{I(LEAK)}$	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V		-1		1	μA
High-Impedance State Output Current	A or B Port	I_{OZ}	V_{CCA}=1.4V, V_{CCB}=2.3V~5.5V		-1		1	μA
Quiescent Supply Current		I_{CCA}	V_{IN}=V_{OUT}=Open I_O=0A	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V		1.5		μA
				V_{CCA}=1.5V~3.6V, V_{CCB}=2.3V~5.5V			2	μA
				V_{CCA}=3.6V, V_{CCB}=0V			2	μA
				V_{CCA}=0V, V_{CCB}=5.5V			-1	μA
		I_{CCB}		V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V		1.5		μA
				V_{CCA}=1.5V~3.6V, V_{CCB}=2.3V~5.5V			6	μA
				V_{CCA}=3.6V, V_{CCB}=0V			-1	μA
				V_{CCA}=0V, V_{CCB}=5.5V			1.4	μA
		I_{CCA}+I_{CCB}	V_{IN}=V_{CCI} or GND I_O=0A	V_{CCA}=1.4V, V_{CCB}=2.3V~5.5V		3		μA
				V_{CCA}=1.5V~3.6V, V_{CCB}=2.3V~5.5V			8	μA
		I_{CCZA}	V_{IN}=V_{OUT}=Open I_O=0A	V_{CCA}=1.4V, V_{CCB}=1.65V~5.5V OE=GND		0.05		μA
		I_{CCZB}				4		μA
Input Capacitance	OE	C_{IN}	V_{CCA}=3.3V, V_{CCB}=3.3V			4.5		pF
Output Capacitance	A Port	C_{IO}	V_{CCA}=3.3V, V_{CCB}=3.3V			6		pF
	B Port		V_{CCA}=3.3V, V_{CCB}=3.3V			5.5		pF

Notes: 1. V_{CCI} is the supply voltage associated with the input port.
2. V_{CCO} is the supply voltage associated with the output port.
3. V_{CCA} must be less than or equal to V_{CCB}, and V_{CCA} must not exceed 3.6V.

■ SWITCHING CHARACTERISTICS (Unless otherwise specified)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Propagation Delay From Input (A) to Output (B)	Push-Pull Driving	t_{PHL}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			11	ns
				V_{CCB}=2.5V±0.2V			9.2	ns
				V_{CCB}=3.3V±0.3V			8.6	ns
				V_{CCB}=5V±0.5V			8.6	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	4		14.4	ns
				V_{CCB}=2.5V±0.2V	3.6		12.8	ns
				V_{CCB}=3.3V±0.3V	3.5		12.2	ns
				V_{CCB}=5V±0.5V	3.5		12	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			8.2	ns
				V_{CCB}=2.5V±0.2V			6.4	ns
				V_{CCB}=3.3V±0.3V			5.7	ns
				V_{CCB}=5V±0.5V			5.6	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	3.6		11.4	ns
				V_{CCB}=2.5V±0.2V	3.2		9.9	ns
				V_{CCB}=3.3V±0.3V	3.1		9.3	ns
				V_{CCB}=5V±0.5V	3.1		8.9	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			5.0	ns
				V_{CCB}=3.3V±0.3V			4.0	ns
				V_{CCB}=5V±0.5V			3.7	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	2.4		6.9	ns
				V_{CCB}=3.3V±0.3V	2.3		6.3	ns
				V_{CCB}=5V±0.5V	2.2		5.8	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			3.8	ns
				V_{CCB}=5V±0.5V			3.1	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	2.0		5.3	ns
				V_{CCB}=5V±0.5V	1.9		4.8	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Propagation Delay From Input (B) to Output (A)	Push-Pull Driving	t_{PHL}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			12.7	ns
				V_{CCB}=2.5V±0.2V			11.1	ns
				V_{CCB}=3.3V±0.3V			11	ns
				V_{CCB}=5V±0.5V			12	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	3.4		13.2	ns
				V_{CCB}=2.5V±0.2V	3.1		9.6	ns
				V_{CCB}=3.3V±0.3V	2.8		8.5	ns
				V_{CCB}=5V±0.5V	2.5		7.5	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			9.8	ns
				V_{CCB}=2.5V±0.2V			8.0	ns
				V_{CCB}=3.3V±0.3V			7.4	ns
				V_{CCB}=5V±0.5V			7.0	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	3.4		12.1	ns
				V_{CCB}=2.5V±0.2V	2.8		8.5	ns
				V_{CCB}=3.3V±0.3V	2.5		7.3	ns
				V_{CCB}=5V±0.5V	2.1		6.2	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			5.4	ns
				V_{CCB}=3.3V±0.3V			4.7	ns
				V_{CCB}=5V±0.5V			4.2	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	2.5		7.3	ns
				V_{CCB}=3.3V±0.3V	2.2		6.0	ns
				V_{CCB}=5V±0.5V	1.8		4.9	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			4.2	ns
				V_{CCB}=5V±0.5V			3.8	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	2.1		5.5	ns
				V_{CCB}=5V±0.5V	1.7		4.5	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Propagation Delay From Input (A) to Output (B)	Push-Pull Driving	t_{PLH}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			12	ns
				V_{CCB}=2.5V±0.2V			10	ns
				V_{CCB}=3.3V±0.3V			9.8	ns
				V_{CCB}=5V±0.5V			9.7	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	182		720	ns
				V_{CCB}=2.5V±0.2V	143		554	ns
				V_{CCB}=3.3V±0.3V	114		473	ns
				V_{CCB}=5V±0.5V	81		384	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			9.0	ns
				V_{CCB}=2.5V±0.2V			2.1	ns
				V_{CCB}=3.3V±0.3V			6.5	ns
				V_{CCB}=5V±0.5V			6.3	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	194		729	ns
				V_{CCB}=2.5V±0.2V	155		584	ns
				V_{CCB}=3.3V±0.3V	126		466	ns
				V_{CCB}=5V±0.5V	90		346	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			5.2	ns
				V_{CCB}=3.3V±0.3V			4.3	ns
				V_{CCB}=5V±0.5V			3.9	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	149		592	ns
				V_{CCB}=3.3V±0.3V	125		488	ns
				V_{CCB}=5V±0.5V	93		368	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			3.9	ns
				V_{CCB}=5V±0.5V			3.5	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	111		439	ns
				V_{CCB}=5V±0.5V	87		352	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Propagation Delay From Input (B) to Output (A)	Push-Pull Driving	t_{PLH}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			9.5	ns
				V_{CCB}=2.5V±0.2V			6.2	ns
				V_{CCB}=3.3V±0.3V			5.1	ns
				V_{CCB}=5V±0.5V			1.6	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	186		745	ns
				V_{CCB}=2.5V±0.2V	147		603	ns
				V_{CCB}=3.3V±0.3V	118		519	ns
				V_{CCB}=5V±0.5V	84		407	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			10.2	ns
				V_{CCB}=2.5V±0.2V			7.0	ns
				V_{CCB}=3.3V±0.3V			5.8	ns
				V_{CCB}=5V±0.5V			5.0	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	197		733	ns
				V_{CCB}=2.5V±0.2V	159		578	ns
				V_{CCB}=3.3V±0.3V	129		459	ns
				V_{CCB}=5V±0.5V	93		323	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			5.9	ns
				V_{CCB}=3.3V±0.3V			4.4	ns
				V_{CCB}=5V±0.5V			3.5	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	150		595	ns
				V_{CCB}=3.3V±0.3V	126		481	ns
				V_{CCB}=5V±0.5V	94		345	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			3.8	ns
				V_{CCB}=5V±0.5V			4.3	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	112		449	ns
				V_{CCB}=5V±0.5V	86		339	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Enable Time From Input (OE) to Output (A or B)	t_{en}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			200	ns
			V_{CCB}=2.5V±0.2V			200	ns
			V_{CCB}=3.3V±0.3V			200	ns
			V_{CCB}=5V±0.5V			200	ns
		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			200	ns
			V_{CCB}=2.5V±0.2V			200	ns
			V_{CCB}=3.3V±0.3V			200	ns
			V_{CCB}=5V±0.5V			200	ns
		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			200	ns
			V_{CCB}=3.3V±0.3V			200	ns
			V_{CCB}=5V±0.5V			200	ns
		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			200	ns
			V_{CCB}=5V±0.5V			200	ns
Disable Time From Input (OE) to Output (A or B)	t_{dis}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			28.1	ns
			V_{CCB}=2.5V±0.2V			22	ns
			V_{CCB}=3.3V±0.3V			20.1	ns
			V_{CCB}=5V±0.5V			19.6	ns
		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			25.1	ns
			V_{CCB}=2.5V±0.2V			18.8	ns
			V_{CCB}=3.3V±0.3V			16.5	ns
			V_{CCB}=5V±0.5V			15.3	ns
		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			15.7	ns
			V_{CCB}=3.3V±0.3V			12.9	ns
			V_{CCB}=5V±0.5V			11.2	ns
		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			11.9	ns
			V_{CCB}=5V±0.5V			9.8	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Input Rise Time (A Port Rise Time)	Push-Pull Driving	t_{rA}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V	3.5		13.1	ns
				V_{CCB}=2.5V±0.2V	3.0		9.8	ns
				V_{CCB}=3.3V±0.3V	3.1		9.0	ns
				V_{CCB}=5V±0.5V	3.2		8.3	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	147		982	ns
				V_{CCB}=2.5V±0.2V	115		716	ns
				V_{CCB}=3.3V±0.3V	92		592	ns
				V_{CCB}=5V±0.5V	66		481	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V	3.1		11.9	ns
				V_{CCB}=2.5V±0.2V	2.6		8.6	ns
				V_{CCB}=3.3V±0.3V	2.7		7.8	ns
				V_{CCB}=5V±0.5V	2.8		7.2	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	155		996	ns
				V_{CCB}=2.5V±0.2V	124		691	ns
				V_{CCB}=3.3V±0.3V	100		508	ns
				V_{CCB}=5V±0.5V	72		350	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V	2.0		7.3	ns
				V_{CCB}=3.3V±0.3V	2.1		6.4	ns
				V_{CCB}=5V±0.5V	2.2		5.8	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	110		692	ns
				V_{CCB}=3.3V±0.3V	93		529	ns
				V_{CCB}=5V±0.5V	68		369	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V	1.8		5.7	ns
				V_{CCB}=5V±0.5V	1.9		5.0	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	75		446	ns
				V_{CCB}=5V±0.5V	57		337	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Input Rise Time (B Port Rise Time)	Push-Pull Driving	t_{rB}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V	2.9		11.4	ns
				V_{CCB}=2.5V±0.2V	1.9		7.4	ns
				V_{CCB}=3.3V±0.3V	0.9		4.7	ns
				V_{CCB}=5V±0.5V	0.7		2.6	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	135		1020	ns
				V_{CCB}=2.5V±0.2V	91		756	ns
				V_{CCB}=3.3V±0.3V	58		653	ns
				V_{CCB}=5V±0.5V	20		370	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V	2.8		10.5	ns
				V_{CCB}=2.5V±0.2V	1.8		7.2	ns
				V_{CCB}=3.3V±0.3V	1.2		5.2	ns
				V_{CCB}=5V±0.5V	0.7		2.7	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	132		1001	ns
				V_{CCB}=2.5V±0.2V	106		677	ns
				V_{CCB}=3.3V±0.3V	73		546	ns
				V_{CCB}=5V±0.5V	32		323	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V	1.8		6.5	ns
				V_{CCB}=3.3V±0.3V	1.3		5.1	ns
				V_{CCB}=5V±0.5V	0.7		3.4	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	107		693	ns
				V_{CCB}=3.3V±0.3V	79		483	ns
				V_{CCB}=5V±0.5V	41		304	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V	1.5		5.0	ns
				V_{CCB}=5V±0.5V	1.0		3.6	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	72		427	ns
				V_{CCB}=5V±0.5V	40		290	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Input Fall Time (A Port Fall Time)	Push-Pull Driving	t_{fA}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V	2.3		9.9	ns
				V_{CCB}=2.5V±0.2V	1.7		7.7	ns
				V_{CCB}=3.3V±0.3V	1.6		6.8	ns
				V_{CCB}=5V±0.5V	1.7		6.0	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	2.4		10	ns
				V_{CCB}=2.5V±0.2V	2.1		7.9	ns
				V_{CCB}=3.3V±0.3V	1.7		7.0	ns
				V_{CCB}=5V±0.5V	1.5		6.2	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V	2.1		8.8	ns
				V_{CCB}=2.5V±0.2V	1.6		6.6	ns
				V_{CCB}=3.3V±0.3V	1.4		5.7	ns
				V_{CCB}=5V±0.5V	1.4		4.9	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	2.2		9.0	ns
				V_{CCB}=2.5V±0.2V	1.7		6.7	ns
				V_{CCB}=3.3V±0.3V	1.4		5.8	ns
				V_{CCB}=5V±0.5V	1.2		5.2	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V	1.5		5.7	ns
				V_{CCB}=3.3V±0.3V	1.2		4.7	ns
				V_{CCB}=5V±0.5V	1.3		3.8	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	1.5		5.6	ns
				V_{CCB}=3.3V±0.3V	1.2		4.7	ns
				V_{CCB}=5V±0.5V	1.1		4.0	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V	1.2		4.5	ns
				V_{CCB}=5V±0.5V	1.1		3.5	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	1.1		4.4	ns
				V_{CCB}=5V±0.5V	1.0		3.7	ns

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Input Fall Time (B Port Fall Time)	Push-Pull Driving	t_{fB}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V	2.0		8.7	ns
				V_{CCB}=2.5V±0.2V	1.3		5.5	ns
				V_{CCB}=3.3V±0.3V	0.9		3.8	ns
				V_{CCB}=5V±0.5V	0.8		3.1	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	1.2		11.5	ns
				V_{CCB}=2.5V±0.2V	1.3		8.6	ns
				V_{CCB}=3.3V±0.3V	1.0		9.6	ns
				V_{CCB}=5V±0.5V	0.5		7.7	ns
	Push-Pull Driving		V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V	2.0		8.3	ns
				V_{CCB}=2.5V±0.2V	1.3		5.4	ns
				V_{CCB}=3.3V±0.3V	0.9		3.9	ns
				V_{CCB}=5V±0.5V	0.7		3.0	ns
	Open-Drain Driving			V_{CCB}=1.8V±0.15V	0.8		10.5	ns
				V_{CCB}=2.5V±0.2V	0.7		10.7	ns
				V_{CCB}=3.3V±0.3V	1.0		9.6	ns
				V_{CCB}=5V±0.5V	0.6		7.8	ns
	Push-Pull Driving		V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V	1.4		5.4	ns
				V_{CCB}=3.3V±0.3V	0.9		4.1	ns
				V_{CCB}=5V±0.5V	0.7		3.0	ns
	Open-Drain Driving			V_{CCB}=2.5V±0.2V	0.4		14.2	ns
				V_{CCB}=3.3V±0.3V	0.5		19.4	ns
				V_{CCB}=5V±0.5V	0.4		3.0	ns
	Push-Pull Driving		V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V	1.1		4.2	ns
				V_{CCB}=5V±0.5V	0.8		3.1	ns
	Open-Drain Driving			V_{CCB}=3.3V±0.3V	1.0		4.2	ns
				V_{CCB}=5V±0.5V	0.8		3.1	ns
Data Rate	Push-Pull Driving	f_{data}	V_{CCA}=1.5V±0.1V	V_{CCB}=1.8V±0.15V			40	Mbps
				V_{CCB}=2.5V±0.2V			60	Mbps
				V_{CCB}=3.3V±0.3V			60	Mbps
				V_{CCB}=5V±0.5V			50	Mbps
	Open-drain Driving			V_{CCB}=1.8V±0.15V			2	Mbps
				V_{CCB}=2.5V±0.2V			2	Mbps
				V_{CCB}=3.3V±0.3V			2	Mbps
				V_{CCB}=5V±0.5V			2	Mbps
Pulse Duration	Push-Pull Driving	t_W		V_{CCB}=1.8V±0.15V	25			ns
				V_{CCB}=2.5V±0.2V	16.7			ns
				V_{CCB}=3.3V±0.3V	16.7			ns
				V_{CCB}=5V±0.5V	20			ns
	Open-drain Driving			V_{CCB}=1.8V±0.15V	500			ns
				V_{CCB}=2.5V±0.2V	500			ns
				V_{CCB}=3.3V±0.3V	500			ns
				V_{CCB}=5V±0.5V	500			ns
Data Rate	Push-Pull Driving	f_{data}	V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V			40	Mbps
				V_{CCB}=2.5V±0.2V			60	Mbps
				V_{CCB}=3.3V±0.3V			60	Mbps
				V_{CCB}=5V±0.5V			60	Mbps
	Open-drain Driving			V_{CCB}=1.8V±0.15V			2	Mbps
				V_{CCB}=2.5V±0.2V			2	Mbps
				V_{CCB}=3.3V±0.3V			2	Mbps
				V_{CCB}=5V±0.5V			2	Mbps

■ SWITCHING CHARACTERISTICS (Cont.)

PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Pulse Duration	Push-Pull Driving	t_W	V_{CCA}=1.8V±0.15V	V_{CCB}=1.8V±0.15V	25			ns
				V_{CCB}=2.5V±0.2V	16.7			ns
				V_{CCB}=3.3V±0.3V	16.7			ns
				V_{CCB}=5V±0.5V	16.7			ns
	Open-drain Driving			V_{CCB}=1.8V±0.15V	500			ns
				V_{CCB}=2.5V±0.2V	500			ns
				V_{CCB}=3.3V±0.3V	500			ns
				V_{CCB}=5V±0.5V	500			ns
Data Rate	Push-Pull Driving	f_{data}	V_{CCA}=2.5V±0.2V	V_{CCB}=2.5V±0.2V			60	Mbps
				V_{CCB}=3.3V±0.3V			60	Mbps
				V_{CCB}=5V±0.5V			60	Mbps
	Open-drain Driving			V_{CCB}=2.5V±0.2V			2	Mbps
				V_{CCB}=3.3V±0.3V			2	Mbps
				V_{CCB}=5V±0.5V			2	Mbps
Pulse Duration	Push-Pull Driving	t_W		V_{CCB}=2.5V±0.2V	16.7			ns
				V_{CCB}=3.3V±0.3V	16.7			ns
				V_{CCB}=5V±0.5V	16.7			ns
	Open-drain Driving			V_{CCB}=2.5V±0.2V	500			ns
				V_{CCB}=3.3V±0.3V	500			ns
				V_{CCB}=5V±0.5V	500			ns
Data Rate	Push-Pull Driving	f_{data}	V_{CCA}=3.3V±0.3V	V_{CCB}=3.3V±0.3V			60	Mbps
				V_{CCB}=5V±0.5V			60	Mbps
	Open-drain Driving			V_{CCB}=3.3V±0.3V			2	Mbps
				V_{CCB}=5V±0.5V			2	Mbps
Pulse Duration	Push-Pull Driving	t_W		V_{CCB}=3.3V±0.3V	16.7			ns
				V_{CCB}=5V±0.5V	16.7			ns
	Open-drain Driving			V_{CCB}=3.3V±0.3V	500			ns
				V_{CCB}=5V±0.5V	500			ns

■ OPERATING CHARACTERISTICS (Unless otherwise specified)

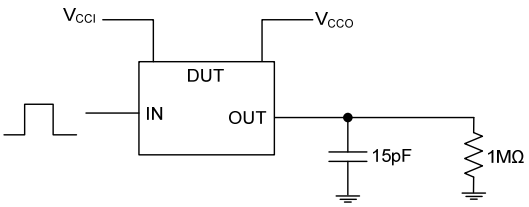
PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Power Dissipation Capacitance	A Port Input B Port Output	C_{PDA}	C_L=0, f=10MHz t_r=t_f=1nS OE=V_{CCA} (Output Enabled)	V_{CCA}=1.5V V_{CCB}=1.5V		5.9		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		5.9		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		6.7		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		8.0		pF
	B Port Input A Port Output			V_{CCA}=1.5V V_{CCB}=1.5V		9.9		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		9.7		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		9.4		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		9.8		pF
	A Port Input B Port Output		C_L=0, f=10MHz t_r=t_f=1nS OE=GND (Output Disabled)	V_{CCA}=1.5V V_{CCB}=1.5V		0.01		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		0.01		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		0.01		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		0.01		pF
	B Port Input A Port Output			V_{CCA}=1.5V V_{CCB}=1.5V		0.01		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		0.01		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		0.01		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		0.01		pF

■ OPERATING CHARACTERISTICS (Cont.)

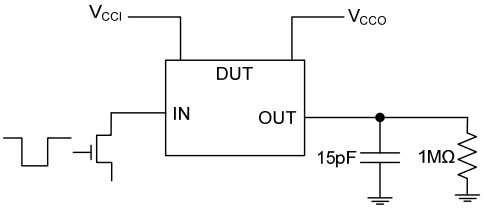
PARAMETER		SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Power Dissipation Capacitance	A Port Input B Port Output	C_{PDB}	C_L=0, f=10MHz t_r=t_f=1nS OE=V_{CCA} (Output Enabled)	V_{CCA}=1.5V V_{CCB}=1.5V		21.5		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		20.8		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		21		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		23		pF
	B Port Input A Port Output			V_{CCA}=1.5V V_{CCB}=1.5V		16.7		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		16.8		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		17.8		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		20.9		pF
	A Port Input B Port Output		C_L=0, f=10MHz t_r=t_f=1nS OE=GND (Output Disabled)	V_{CCA}=1.5V V_{CCB}=1.5V		0.01		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		0.01		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		0.01		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		0.02		pF
	B Port Input A Port Output			V_{CCA}=1.5V V_{CCB}=1.5V		0.01		pF
				V_{CCA}=1.8V V_{CCB}=1.8V		0.01		pF
				V_{CCA}=2.5V V_{CCB}=2.5V		0.01		pF
				V_{CCA}=3.3V V_{CCB}=3.3V		0.02		pF

■ TEST CIRCUIT AND WAVEFORMS

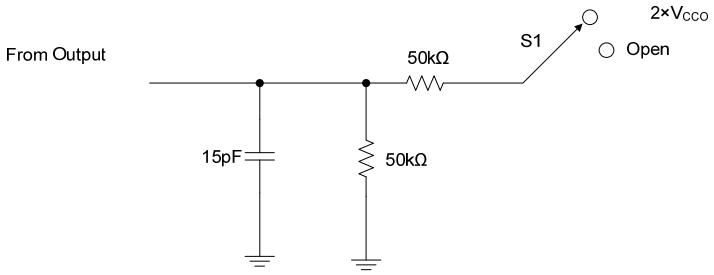
Load Circuits



Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

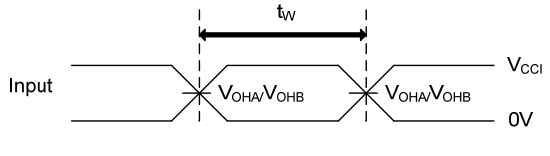


Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver

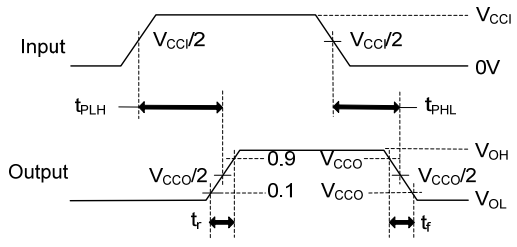


TEST	S1
t_{PZL}/t_{PLZ}	$2\times V_{CCO}$
t_{PHZ}/t_{PZH}	Open

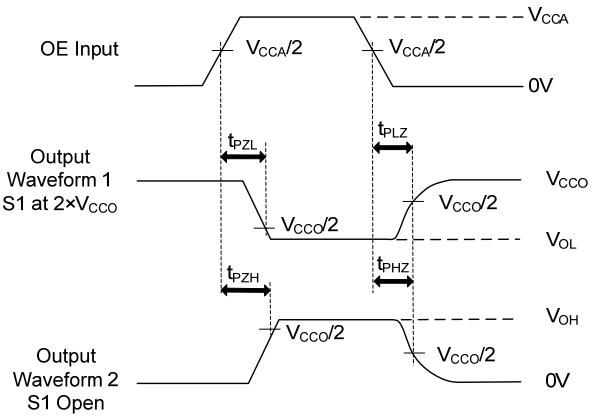
Notes: 1. V_{CCI} is the supply voltage associated with the input.
2. V_{CCO} is the supply voltage associated with the input.
3. t_{en} is the same as t_{PZL} and t_{PZH}.
t_{dis} is the same as t_{PLZ} and t_{PHZ}.



PULSE DURATION



PROPAGATION DELAY TIMES



ENABLE AND DISABLE TIMES

■ DETAILED DESCRIPTION

Overview

The **UTXS0108** can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The **UTXS0108** is ideal for use in applications where an open-drain driver is connected to the data I/Os. The **UTXS0108** can also be used in applications where a push-pull driver is connected to the data I/Os, but the UTXB0104 might be a better option for such push-pull applications. The **UTXS0108** device is a semi-buffered auto-direction-sensing voltage translator design is optimized for translation applications (e.g. MMC Card Interfaces) that require the system to start out in a low-speed open-drain mode and then switch to a higher speed push-pull mode.

Architecture

To address these application requirements, a semi-buffered architecture design is used and is illustrated below (see Figure 1). Edge-rate accelerator circuitry (for both the high-to-low and low-to-high edges), a High-Ron n-channel pass-gate transistor (on the order of 300Ω to 500Ω) and pull-up resistors (to provide DC-bias and drive capabilities) are included to realize this solution. A direction-control signal (to control the direction of data flow from A to B or from B to A) is not needed. The resulting implementation supports both low-speed open-drain operation as well as high-speed push-pull operation.

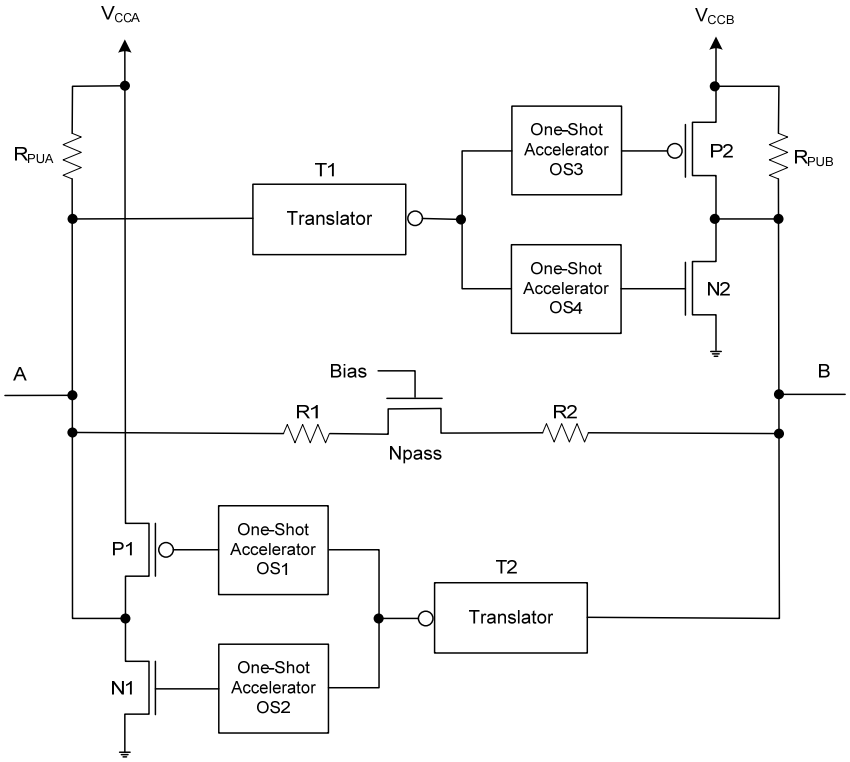


Figure 1. Architecture of UTXS0108 I/O Cell

When transmitting data from A to B ports, during a rising edge the One-Shot (OS3) turns on the PMOS transistor (P2) for a short-duration and this speeds up the low-to-high transition. Similarly, during a falling edge, when transmitting data from A to B, the One-Shot (OS4) turns on NMOS transistor (N2) for a short-duration and this speeds up the high-to-low transition. The B port edge-rate accelerator consists of one-shots OS3 and OS4, Transistors P2 and N2 and serves to rapidly force the B port high or low when a corresponding transition is detected on the A port.

When transmitting data from B to A ports, during a rising edge the One-Shot (OS1) turns on the PMOS transistor (P1) for a short-duration and this speeds up the low-to-high transition. Similarly, during a falling edge, when transmitting data from B to A, the One-Shot (OS2) turns on NMOS transistor (N1) for a short-duration and this speeds up the high-to-low transition. The A port edge-rate accelerator consists of one-shots OS1 and OS2, Transistors P1 and N1 components and form the edge-rate accelerator and serves to rapidly force the A port high or low when a corresponding transition is detected on the B port.

■ DETAILED DESCRIPTION (Cont.)

Power-Up

During operation, ensure that $V_{CCA} \leq V_{CCB}$ at all times. During power-up sequencing, $V_{CCA} \geq V_{CCB}$ does not damage the device, so any power supply can be ramped up first.

Enable and Disable

The **UTXS0108** has an OE input that is used to disable the device by setting OE low, which places all I/Os in the Hi-Z state. The disable time (t_{dis}) indicates the delay between the time when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time (ten) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

Pull-up or Pull-down Resistors on I/O Lines

Each A port I/O has a pull-up resistor (R_{pua}) to V_{CCA} and each B port I/O has a pull-up resistor (R_{pub}) to V_{CCB}. R_{pua} and R_{pub} have a value of 40kΩ when the output is driving low. R_{pua} and R_{pub} have a value of 4kΩ when the output is driving high. R_{pua} and R_{pub} are disabled when OE = Low.

■ TYPICAL APPLICATION CIRCUIT